female, who is the reputed creator of living things and whose abode is in the sky. Animatism prevails, and were-tigers and were-leopards are a feature in the popular beliefs. With all these matters Mr. Hutton deals interestingly and in some detail, though he wisely assumes a cautious attitude in describing the native beliefs in view of the uncertainty of the material.

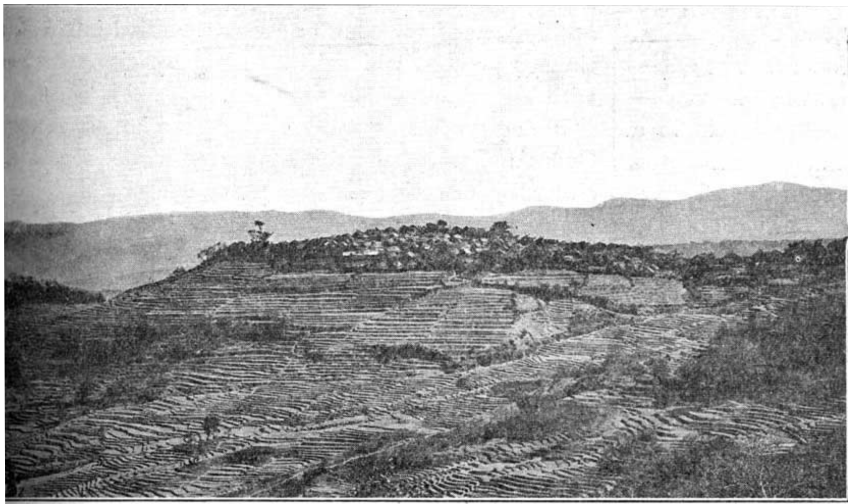

Fig. 3.—Viswema village showing terraced fields. From "The Angami Nagas."

The arts, industries, amusements, and general domestic life, the laws and customs and other culture-phenomena all receive adequate attention, and a number of traditions, legends, and songs are recounted. An important chapter deals with the Angami language, which belongs to the Tibeto-Burman group. There are also several valuable appendices concerned with special points, including a series of anthropometric measurements. It is to be hoped that the Stone Age of the Naga Hills may be the object of further researches. Our knowledge of it is mainly, almost exclusively, derived from stone celts which are locally believed to be thunderbolts, and are valued as such by the natives. One assumes that other types of stone implements, which may be revealed by careful search, must have been associated with the celts. They should throw light upon the archæology of the region, a subject which as yet remains obscure.

A few words of criticism are called for. Some of Mr. Hutton's descriptions are by no means clear. For instance, on p. 68 mention is made of a "trumpet" upon which military bugle-calls are reproduced, but which is not "blown with a loose lip." If this is so, the instrument should not be described as a "trumpet," and one wonders how bugle-calls can be imitated without the "loose-lip" method of sound-production. Again, on p. 93, we learn that "millet and Job's tears . . . are . . . used for making rice beer," but these ingredients are not referred to in the description of the brewing of this staple drink, and one remains uninformed as to their function in the process. On p. 94 the reasons given for the food-*genna* to women are far from clear, and require further elucidation to show the connection of ideas. In a future edition of this excellent book it will be well if all native words and place-names are accented throughout, so as to assist the uninitiated in their correct pronunciation. This should be a general rule in all works of this nature. The illustrations are mostly good, several are very good, and they are well placed in reference to the text, but references to particular figures should appear in the letterpress. Three useful maps are added.

Mr. Hutton's enthusiasm and industry in recording the details of native life in the Naga Hills are evidenced not only in his book upon the Angamis, but also in his more recently published work on the Sema Nagas. These books are so full of information in regard to this important ethnological region that one thirsts for more, and can only hope that other Naga tribes (the Aos, Rengmas, Konyaks, etc.) may be described in a similar manner. "The Angami Nagas" may well serve as a model for further monographs. We congratulate Mr. Hutton and his readers upon a valuable and enlightening piece of work.

Henry Balfour.

The Manufacture of Explosives.

Ministry of Munitions and Department of Scientific and Industrial Research: Technical Records of Explosives Supply, 1915–1918. No. 1: *Recovery of Sulphuric and Nitric Acids from Acids used in the Manufacture of Explosives: Denitration and Absorption.* Pp. viii + 56. 12*s*. 6*d*. net. No. 2: *Manufacture of Trinitrotoluene* (TNT) *and its Intermediate Products.* Pp. viii + 116. 17*s*. 6*d*. net. No. 3: *Sulphuric Acid Concentration.* Pp. vi + 91. 12*s*. net. No. 4: *The Theory and Practice of Acid Mixing.* Pp. vi + 93. 12*s*. net. (London: H.M. Stationery Office, 1920–1921.)

THE first four of the series of publications dealing with the technical records of explosives supply now to hand form a valuable addition to the literature of technical chemistry. The work of preparing the information was begun by Mr. W. Macnab under the Ministry of Munitions, and thanks are due to the Department of Scientific and Industrial Research for arranging for his retention to complete it.

Denitration.—The first volume deals with the recovery of the nitric and sulphuric acids from the waste acid produced in the nitration of toluene and glycerine. Not only is the proportion of waste acid a large one—650 tons for 100 tons of trinitrotoluene produced—but the efficient recovery of the sulphuric acid in a condition suitable for concentration, and of the nitrogen oxy-acids as nitric acid, constitutes one of the principal economic factors of the manufacture.

The chemical reactions involved in denitration have been the subject of discussion both earlier and as a result of experience in war factories, and the position is summed up in the introduction to this volume. It may briefly be said that by considering the behaviour of nitrosylsulphuric acid when it acts on nitric acid, and when it breaks down on dilution with water, a fairly coherent explanation is afforded of what goes on during the progress of waste acids down a denitrating tower as they meet an ascending current of steam.

The treatment of the subject of the absorption of the nitrous fumes coming from the towers to form 55 per cent. nitric acid is of importance at the present time, when this problem confronts any manufacturer proposing to make nitric acid by the catalytic oxidation of ammonia. The experience recorded is that a 90 per cent. conversion of nitrogen peroxide to nitric acid can be secured with a ratio of free tower space to rate of passage of nitrogen peroxide, which is less than a tenth of that in large towers erected for the same purpose in connection with the oxidation of ammonia. The relative effectiveness of the small towers with the most advantageous conditions of concentration and velocity of gases and free space, temperature, and concentration of nitric acid, is clearly indicated, and forms a basis for modification of the present practice of installing immense absorption towers which are obviously inefficient and very costly.

Full detailed drawings are given of the plant for the processes of denitration, absorption, and storage of acids, and its applicability to the manufacture of organic nitro-bodies should make the report of interest and importance to a wider field than that of the explosive manufacturer alone.

Trinitrotoluene Manufacture.—No. 2 of this series gives the history of processes for making trinitrotoluene and for its purification, and describes plant and manufacturing methods. An account is given of the experimental work at the Research Department, Woolwich, which established the conditions necessary for nitration, the advantage of the extraction of waste acids ("detoluation") by mononitrotoluene, itself to be nitrated later, and the benefits of a cyclic system of nitration in stages in order to conserve acids. These features were embodied in the processes followed in the large factories erected for making trinitrotoluene, an important variation, however, being the elaboration at Oldbury of the counter-current method into a continuous process, which had a high capacity combined with low labour and capital cost.

In the process as carried out at the largest factory, Queen's Ferry, mononitrotoluene, made separately either by nitrating gas-works toluene or the toluene contained in Borneo petroleum, was used to detoluate waste acids which had themselves been detoluated by once-used mononitrotoluene, brought up to nearly dinitrotoluene in the last-mentioned operation, and this dinitrotoluene was then nitrated to trinitrotoluene.

The next process, that of freeing the crude trinitrotoluene from acids, underwent some elaboration, for in addition to agitation of the molten trinitrotoluene by hot water it was found efficacious to chill it by pelleting it in cold water, and to use weakly basic hydrolysable salts for the hot washing; a continuous system of hot washing was also developed.

But although it became possible latterly to push the process of nitration until nearly all the dinitrotoluene had been converted into trinitrotoluene, there remained about 4 per cent. of its unsymmetrical isomerides resulting from the nitration of the meta-nitrotoluene. While the crude trinitrotoluene, after having been washed and dried, could be used in large quantities for making the bulk of the amatol for filling shell, there were certain purposes for which a purer product was demanded, when, for example, the ammonium nitrate was not free from pyridine and thiocyanate, or when it was necessary to avoid the low melting-point eutectics formed by the isomerides. Purified trinitrotoluene was prepared at first by crystallisation from, or by washing with, organic solvents, and large factories were erected for these purposes. Later, a process was adapted from the French, safer from the point of view of fire-risk, and characterised by treating the crude trinitrotoluene with sodium sulphite solution which under suitable conditions selectively dissolves out the other isomerides, leaving the pure symmetrical trinitrotoluene and any dinitrotoluene that has escaped further nitration. As this process was one which could readily be embodied in the scheme of manufacture, it was carried out in the trinitrotoluene factory.

The plant at Queen's Ferry, which in every detail is stamped with the genius of Mr. K. B. Quinan, is described in this volume in all relevant particulars as to the main features of the manufacture. The reproductions of the working drawings, the diagrams and flow-sheets, the detailed sketches of parts and of special devices, and the examples of methods of statistical control, constitute a body of information of a unique character. The description forms a permanent record of these matters in a connected narrative, but again its usefulness is by no means confined to the explosives manufacturer, since many of the methods used and devices for overcoming difficulties are subject-matter for numerous projects in chemical engineering.

Concentration of Sulphuric Acid.—In the third volume will be found a useful study of the thermal conditions obtaining in the Gaillard tower system. The methods used before the war in this country for concentrating the sulphuric acid of 70 per cent. strength resulting from processes of nitration were for the most part the Kessler and the cascade systems, both of which are operated with comparatively small units. Excellent results both as regards efficiency and low cost of working were obtained with the large Gaillard towers erected in the large explosives factories such as Queen's Ferry and Gretna. The feature of these towers is the conversion of the weak acid into a spray, which in falling by gravity down a tower of about 50 ft. in height, meets ascending hot gases from a producer, and so becomes concentrated to a strength of 92-95 per cent. sulphuric acid. As the fuel consumption, weight of dilute acid, and weight of concentrated acid can be measured with fair accuracy, the opportunity is taken to calculate the efficiency of the plant from a knowledge of the various thermal data available, including those of Porter for sulphuric acid and oleum. The various factors are considered in detail which will repay the study of technical students, and a satisfactory heat balance is made out in which the heat imported into the system is contrasted with that which is lost by water evaporating, by radiation, and by being carried away in the hot acids. As the last-mentioned source of loss amounts to nearly a quarter of the heat put into the system, its recovery on counter-current lines by suitable constructional modifications would appear to be worth attempting.

A short study follows of the Gilchrist concentrating plant, which worked on a process analogous to that of the Kessler plant, but with a high capacity.

It had been a disadvantage in all the varieties of concentrating plant mentioned that the gases finally discharged into the air carried with them a mist of dilute sulphuric acid in water, involving a certain loss of acid and considerable inconvenience to those working in the neighbourhood. It was also objectionable in explosives factories where many large-scale operations have to be conducted in an acid-free atmosphere. Accordingly it was determined to precipitate this mist electrically by the Cottrell electrostatic process, of which full details are given and also a description of all the electrical parts and their mode of maintenance. As about 3 per cent. of the acid fed into the concentrating plant was recovered in the Cottrell precipitating plant, it will be seen that besides the advantages mentioned, a useful addition to the yield of acid was obtained.

Acid Mixing.—In No. 4 of this series is described the working of that important section of a nitration factory in which the acids are adjusted as regards their quantity and composition. In such a factory as Queen's Ferry, where 700 tons of trinitrotoluene a week could be made, the magnitude of the problems of production, handling, and conveyance of acids may be judged from the vast quantities—about 43,000 gallons—of nitric and sulphuric acids occurring in many stages of dilution. It is essential to secure that the various acids are in balance for controlling the cycle of production and recovery in manufacture. An example for a given output of explosive is worked out, and a diagrammatic acid balance figured, which includes a set of factors by which the quantities of acid at various stages must be modified to compensate for variations in working of the units composing the acids cycle. In this way the proper quantity of mixed nitrating acids of a definite composition and the economical utilisation of spent acids are kept under strict control.

As variations in dilution and in strength of the concentrated sulphuric and nitric acid inevitably creep in, calculations must be made of the adjustments necessary to bring the contents of the large mixing vessels to the desired composition. The methods for doing this are explained, and it is of interest to note that the presentment of the necessary data in the form of graphs was abandoned in favour of a series of simple tables by means of which the necessary additions for obtaining a correct mixing could be found.

A description is given in detail of the plant for storing and mixing these acids, and this completes the account of the manufacture of trinitrotoluene contained in vol. 2.

Apart from its value as an exposition of scientific method applied to the control of acid mixing for a nitration process on the largest scale, there will be found other subject-matter, such as descriptions of the mechanical details, methods of controlling undue rise of temperature, prevention of wear of parts, and methods of distribution of acids by pipes, which will be found to have a wide interest among those concerned with the erection of plant.

It is clear that the publication of the data which have accrued in the operation of these factories will form a permanent record of the application of scientific method to problems of chemical industry, as well as affording typical examples for the use of students as well as of manufacturers. It is to be regretted that Queen's Ferry factory, which embodies so much original work in plant construction, is now for disposal, but it is understood that while there is yet time the Disposals Board have acquiesced in an arrangement for students to study the plant. A course of this kind with Mr. Macnab's volumes as text-books should prove a very valuable means of instruction.

Popular Expositions of Relativity.

Relativity and the Universe: A Popular Introduction into Einstein's Theory of Space and Time. By Dr. Harry Schmidt. Authorised Translation by Dr. Karl Wichmann. Pp. xiii + 136. (London: Methuen and Co., Ltd., 1921.) 5*s.* net.

The Ideas of Einstein's Theory: A Theory of Relativity in Simple Language. By Prof. J. H. Thirring. Translated by R. A. B. Russell. Pp. xv + 167. (London: Methuen and Co., Ltd., 1921.) 5*s.* net.

An Introduction to the Theory of Relativity. By L. Bolton. Pp. xi + 177. (London: Methuen and Co., Ltd., 1921.) 5*s.* net.

Relativity and Gravitation. Edited by J. Malcolm Bird. Pp. xiv + 245. (London: Methuen and Co., Ltd., 1921.) 8*s.* 6*d.* net.

The Rudiments of Relativity: Lectures delivered under the Auspices of the University College, Johannesburg, Scientific Society. By Prof. J. P. Dalton. Pp. vi + 105. (London: Wheldon and Wesley, Ltd., 1921.) 5*s.* net.

Die Einsteinsche Gravitationstheorie: Versuch einer allgemein verstandlichen Darstellung der Theorie. Von Prof. G. Mie. Pp. iv + 67. (Leipzig: S. Hirzel, 1921.) 7 mk.

HERE are six accounts of the Relativity theory designed for the general reader. The first four hail from Messrs. Methuen, who had the enterprise to secure an English translation of Einstein's own popular exposition, and have also recently published a translation of Weyl's "Space, Time and Matter." The fifth is published in Johannesburg by the Council of Education, Witwatersrand. The last comes from the pen of an eminent German professor of physics.

In surveying such a collection it is appropriate to quote from the last named. "We cannot penetrate into the thought-world of a symphony by reading a description of it, be it by the most distinguished musical critic. The symphony must be heard. The more we analyse it note by note, and the more deeply we understand the relations of the notes, the more do we come into the real meaning of the work."

That is the feeling which emerges after going one after another through many attempts to describe this new theory without asking the reader that he should first equip himself for the act of appreciation by an intimate study of the technique and terminology of geometry, of the significance of Newton's theory of gravitation and his system of mechanics both as an explanation of known phenomena and as forming the whole basis of the further development of physical science. But even granting these prime requisites, the reader is desired, on the strength of the reading of a few simple pages, to readjust the whole of his outlook on the world to an degree even greater than that required for one brought up in a classical school of art to comprehend the strivings of the moderns to find a new mode of expression for the thoughts of a new age.

This much is certain, that there is no short-cut to an understanding of Einstein's achievement. What is the most that we can expect from these many attempts to supply the public with some answer to their inquiries for light on this latest achievement of the imagination and intellect in co-operation? We may legitimately ask for some presentation of the historical setting. But even here we are faced with a great difficulty in providing an account which is free on the one hand from technical difficulties and on the other from misleading vagueness. For the precise statement of the actual achievements of Newton is in itself a matter requiring so much detail that the majority of our university students would not show up well in an examination on this subject. They are content with a parrot-like learning of the conventional language in which the laws of motion are expressed, and a false facility in doing problems without any reference to their physical significance. Meanwhile the Newtonian conceptions of space and time are absorbed as if they were strictly obvious, whereas the mere fact of the existence of Newton's definitions of absolute space and time shows that after all his investigations he found himself bound to postulate something which his reason and conscience could not justify. Newton's absolute space, like Euclid's axiom of parallels, were last confessions of remaining mysteries rather than preliminary statements of the obvious.

Yet it is not possible to appreciate the bearing of the relativity theory without appreciating first the point at which the classical mechanics is unsatisfactory. For it is perhaps the greatest merit of Einstein's work that it gives us something which is more satisfactory